

AIRPORT DEVELOPMENT

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The great cities of the Atlantic Seaboard owe their start to the availability of safe harbors when water transportation was the one best way. Some of the inland cities pushed up into the leading group when rail lines were laid and a new form of transportation added its forces.

A new form of transportation, the airplane, is demanding attention and with it a new set of problems for the engineer. The task of arriving at the proper solution rests upon the man best equipped to assume that responsibility. This means that the trained and experienced engineer will work out a solution for the difficulties which the pilot has met: it does not mean that the pilot will establish himself as an airport engineer and offer his own solutions. If the pilot should be an engineer as well, then the happy combination will satisfy the first and only essential requirement.

The interest of the road engineer is a legitimate one. Many of the principles of traffic control which have been worked out in connection with the safe use of the highways are of value in solving the new problems. The construction and care of the airport and its runways call on no other branch of the profession to the extent that they do on the highway engineer with his training in the study of grading, draining, surfacing, snow removal, and maintenance.

In Detroit the responsibility for the development and operation of the airport has been assigned to the chief paving engineer of the City Engineer's Office, and in other places similar procedure has been followed. The Wayne County Airport is being developed by the Road Commission, under the immediate supervision of the engineer-manager. The State of Michigan has an advisory aeronautical board in liaison with the staff of the State Highway Commissioner.

Airports Are Legitimate Municipal Enterprises

The right of a municipality to acquire, own, and operate an airport seems to have been definitely established. The expenditure of public money for this purpose has been contested

in various localities, and the courts in promulgating their opinions have commented on the different phases which were presented.

Among the important examples, we have the case of the State of Oregon versus the City of Roseburg, (*McClintock v. City of Roseburg, (Ore.) 273 Pac. 331*, decided Jan. 8, 1929). The court decided that a public rather than a private purpose was served by the establishment and maintenance of an airport.

“What is a public use is not capable of an absolute definition. A public use changes with changing conditions of society, new appliances in the sciences and other changes brought about by increased population and modes of transportation and communication. We cannot close our eyes to the great growth in the use of flying machines during the past decade. This growth has been especially noticeable during the last two or three years. We must take notice that a large quantity of mail is being daily transported into the various parts of the country. Express and even freight are being transported by airplane in large and rapidly increasing quantities. Transportation by air appears to be increasing so rapidly that we may confidently expect that soon a large portion of the mail and express will be transported by airplane. An airport owned by the city open to the use of all airplanes is for the benefit of the city as a community, and not of any particular individuals therein. It is, therefore, a public enterprise. Airplanes travel the ‘trackless air’. The only way an airplane company could acquire a monopoly would be through monopolizing the airport. It would seem, therefore, that airports may be properly owned and controlled by a municipality or other public corporation.”

In Missouri, we have the case of *Ennis versus Kansas City, (Mo.) 11 S. W. (2d) 1054*, and the case of *Dysart v. City of St. Louis, 11 S. W. (2d) 1045*. The decision of the Missouri Supreme Court rendered December 8, 1928, was to the effect that the provision of an airport was a “public purpose” for which an indebtedness might be incurred.

The same point was established in the case of the State of Nebraska *v. City of Lincoln, (State ex rel. City of Lincoln v. Johnson, (Nebr.) 220 N. W. 273*, decided June 27, 1928) and in the case of *Mayor Doughty v. City Council of Baltimore, Md. (141 Atl. 499*, decided April 11, 1928).

In Cleveland it was asserted that the issuing of bonds for airport purposes was a direct violation of the provisions of the State Constitution governing the raising of money or loaning of credit to, or in aid of, a corporation or company. The right to establish and operate the airport as planned by the Cleveland ordinance was upheld by the decision on April 19, 1927, (*Hile v. City of Cleveland*, 26 Ohio App. 158, 160 N. E. 241).

A New York case—*Hesse v. Rath*, 164 N. E. 342—tested the New York law of 1928 which authorized cities to establish airports. It was contended that this was not a “city purpose” and hence cities could not incur debts therefor. In a decision rendered on December 7, 1928, the New York Court of Appeals said, “We think the purpose to be served is both public and municipal. A city acts for city purposes when it builds a dock or a bridge or a street or a subway. Its purpose is not different when it builds an airport. *Wichita v. Clapp*, 125 Kan. 100, 263 P. 12. Aviation is today an established method of transportation. The future, even the near future, will make it still more general. The city that is without the foresight to build the ports for the new traffic may soon be left behind in the race of competition. Chalcedon was called the city of the blind, because its founders rejected the nobler site of Byzantium lying at their feet. The need for vision of the future in the governance of cities has not lessened with the years. The dweller within the gates, even more than the stranger from afar, will pay the price of blindness.”

The Necessity for Airports

The recent rapid development of general interest in aviation has emphasized this need. The provision of suitable terminals is just as essential for this as for any other kind of transportation. Automobiles would be useless without garage facilities and parking privileges. The service that a railroad can perform is governed largely by its yards and terminals. Shipping by water is economically possible only through ports where adequate docks and wharves have been provided and a satisfactory harbor can be found. The development of the airplane has already reached the stage where the limit of its usefulness seems fixed only by the places which may be provided for taking-off and landing.

The recent months have been made noteworthy by the eagerness on the part of municipalities throughout the United States to make up this deficiency. Money, totaling an immense sum, has already been provided for this purpose. More will be forthcoming.

In a recent statement before the Common Council at Detroit, Mr. Stout said that Detroit needed not one, but twenty airports. This need is demonstrated by the actual development: in the Detroit area there are no less than thirty-one places that are or have been in regular use as landing fields.

Not all of these fields are to be considered as being adapted for general aviation purposes; as a matter of fact, some of them are in reality nothing more than unimproved meadow or subdivision property which, by reason of its natural contour, location, or other consideration, was attractive for small scale operations at practically no expense. However, in view of the fact that these fields had been used and had been the subject of occasional inquiry, it was decided, as a matter of record if nothing else, to compile the facts relative to all such sites used for aviation purposes, regardless of the fact that they may now be inactive and of doubtful value.

Such a survey is of great benefit in determining the value of various sites for various purposes and is also of value in ascertaining the necessity for additional facilities in certain locations. The results of the survey for the Detroit area are available in printed form in a booklet, "Aircraft Landing Facilities in the Detroit District".

Selection of the Site

The selection of an airport site and the conversion of such a site into an adequate terminal mark a definite forward step which today is being taken by many cities represented in this organization.

Selection of the airport site should be preceded by a study which will take into consideration the purposes which the airport will serve, the various factors of value in satisfying such needs, and the elements of cost.

The proposed expenditure will be expected to satisfy various related needs. These needs should be carefully studied and their relative importance weighed. The characteristics of standard sites as set up in the requirements of the United

States Department of Commerce should then be examined with these requirements in mind in order to determine their fitness to serve the needs thus established. Student training, sales demonstration, club service, experimental work, exhibitions, circuses, national guard training, and mail, express, sightseeing, and taxi service are not satisfied equally by the same features of a single field. It may be possible that more than one field is to be made available. If so, a smaller field close in may answer all the essential requirements for a downtown terminal catering to mail, express, and some scheduled passenger flights. Another location more remote may then very well be selected for the services that require larger areas. The only difference in such a case is that we no longer have a single selection to make, but more than one, and that these selections will be based on different requirements.

The ideal field should be close to the downtown centers, close to the center of population, and should be situated for the greatest convenience of the approaching pilot. It should have at hand the best means of surface transportation. The neighborhood should be suitable. It should be free from fog and smoke. Its surface and area should be such as to permit the maximum use in all seasons and under all conditions of weather. Probably no field which will be considered will have a perfect score. That will be for the ideal alone and the ideal will usually be unattainable. But the total points scored by any field or the total units of suitability will be a valuable guide for further study.

If it were necessary only to secure the greatest possible area for a predetermined sum of money, the selection would be a simple affair. But there are other factors. Some of these are obvious; some are apparent only after study. The greater the number of these factors, the more difficult becomes their relative valuation and the more apparent becomes the necessity for comparison on an engineering basis.

A practical application of this method has been tried at Detroit. The people of Wayne County, Michigan, voted at the election on November 8, 1927, an approval of a bond issue of \$2,000,000 for the purpose of securing a site or sites for municipal airport purposes. To the Ways and Means Committee of the Board of Supervisors was delegated the task of making recommendations. This group in turn was advised by a special Airport Committee of five men. After several

months of study and examination of sites this Airport Committee employed the services of an airport designer to make a survey and suggestions. It is said that 122 proposed sites were examined. Of these, 15 appeared in the report submitted. General information about the 15 sites was included in the report and sites numbered 1, 2 and 3 indicated as first, second, and third choice, respectively. The numbers of other sites did not bear any relationship to their desirability as airport locations. A suggestion as to the development of the three sites was also offered.

The Airport Committee after an examination of the report failed to agree, the majority report being in favor of site No. 8 and the minority in favor of No. 2. The Ways and Means Committee in turn considered all the sites reported and some which were submitted after the filing of the preliminary survey. They narrowed the field down to six possible sites for final consideration.

At this point the engineer-manager of the Wayne County Road Commission and the city engineer of Detroit were asked to co-operate in setting up a *scoring system* on the basis outlined herein. The request did not call for a choice, but for a means of assisting the committee in making that choice.

Since the final scoring was apparently to be in non-technical hands, it was considered advisable to simplify the process as far as possible. A chart was prepared in which the items of operation value and the items of location were set up under the single heading "Factors," subdivided into nine items scoring a possible total of 1,000 points. The total cost set up included all the cost necessary to bring the sites to a uniformly comparable basis. From these two totals the index cost could be obtained by dividing the total cost by the total points scored.

It was also pointed out that "each of the areas with the construction contemplated will comply with the essential requirements of an 'A-1-A' airport. The additional factors which have been set up attempt to evaluate the other desirable features. These values have been placed only after careful consideration of their relative importance. They are applicable to the Wayne County area only and would be varied for any other location where basic conditions are different."

The rating takes into consideration the probable use for student training and for plane manufacturers' testing and

sales demonstrations, etc., as well as use by private individuals and for public demonstrations. The distribution shown by the report is as follows:

1. **Center of Population—(170).** Under this general heading have been grouped manufacturing centers, retail trade centers, accessibility of airport to individual citizens, proximity to aviation clubs, and comparative ease of reaching any portion of the city by taxicab. The time required to reach the port at reasonable automobile speeds is a factor in the distribution between sites.

2. **Downtown Centers—(290).** In setting up values for this factor, consideration was given to the situation of the post office, express offices, the financial district, depots, hotels, and water terminals, and the means of reaching these various centers.

In fixing this value, and the preceding one, credit has been given to the fact that there is an available port at French and Lynch Roads; otherwise the rate would have been put even higher. Time is also a factor.

3. **Airways—(180).** Transcontinental lines were weighted for the percentage of traffic inbound from each direction, and the probable future growth of traffic on lighted airways.

4. **Transportation Facilities—(120).** Under this heading the situation of existing bus lines, paved roads, and trolley lines was weighted, but it is recognized that these facilities can be easily supplied if lacking and are, therefore, not a determined factor in the selection of airports.

A greater value was given to the proximity of railroads, as aids to the development of airplane factories and accessory manufacturing plants, and as means of exchange of mail and express and possibly of commuter service, keeping in mind the fact that the railroad is not much faster than the automobile within the city limits and that air-travel business of itself will probably not justify train service at schedules to accommodate air business alone. It will require the building up of heavy suburban population to warrant frequent commuter service. It must also be borne in mind that railroad service is not as flexible as that of the bus or the individual motor car.

5. **Character of Neighborhood—(40).** Restrictions. In the consideration of this factor the building restrictions or

possible zoning regulations which might place a limitation on the character of the buildings in the neighborhood should be taken into consideration so that the future development of sites for airplane factories and allied industries and for homes for workers at these industries may be taken into account as well as the probability of construction of high buildings or other undesirable areas under take-off.

6. **Fog—(40).** Fog and mist were not rated with smoke because we feel that the distribution of effect is not the same.

Records of 20 years at the local Weather Bureau show that fog occurs usually in the morning before sunrise and disappears usually before noon. The average number of days of dense fogs per year is 12. Records of the Weather Bureau are confined to downtown areas and may not be applied to other points without recognizing the fact that conditions vary. Fogs, though generally found in low and moist spots, may occur in widely scattered localities and sometimes at higher elevations. Such instances are more like very low-hanging clouds or low ceiling.

7. **Smoke—(40).** The character of smoke distribution is determined by the location of the manufacturing districts, the season of the year, and the directions of the prevailing winds.

The prevailing wind in this region is from the southwest and therefore the south and west sides would be least often interfered with by the presence of smoke. Rating value takes into consideration the fact that the airport will probably be far enough from downtown and manufacturing districts to reduce the importance of smoke.

8. **Area—(100).** If no maximum or minimum restrictions were to be placed on the size of the site selected, this factor would be of great importance. A minimum restriction of area large enough to provide a No. 1 rating is presumed. A maximum area of one mile square is also presumed, and no credit for airport purposes is allowed beyond that size. It is believed that if any areas larger than one square mile are being contemplated, then, for purposes of comparison, the price for one square mile should be used.

9. **Soil and Ground Conditions—(20).** Value for this item is set low because artificial drainage will be needed for any site selected. The ease of drainage will be reflected in the cost of sewers. This factor will be higher for clay than for

sandy soil. The low land will presumably be the most difficult to drain, especially if the tests indicate wet clay under a considerable portion of the area.

In considering this factor allowance should also be made for the effect of rain on top soil and the possibility of securing a quick growth of tough sod. It is presumed that a reasonable amount of hard surface runways will be provided for any field which may be selected.

10. Other Items (Not Rated). Telephone, telegraph, light, and power are not set up for comparison because they are easily available in nearly every part of the country.

Water is available at most sites and, if not available, can be secured with the cost included as a part of the total cost of the airport.

No value has been set up for possible official connection with transcontinental railroad traffic. This is something which can be given such weight as the character of the evidence submitted seems to warrant.

The Committee may also wish to consider the time it will take to acquire the property. The fact that some tracts are completely under one control is given no weight here.

Costs. To the initial price of the land should be added the estimated cost of clearing and grubbing, of grading and draining, and of any other items essential to make the fields comparable. This total cost thus obtained for any particular site, divided by the points scored for that site, will give an index of cost which may aid in selecting one from a number of sites of almost equal desirability.

After the report was submitted and in response to an informal request, this scheme was carried further by actually filling in tentative values for the six sites by preparing charts which showed graphically the basis upon which these scores were made. These figures as set up gave site No. 1 the highest score, if money were not considered, and sites No. 2 and No. 8 the next highest score. When the costs were considered, it was found that the lowest cost per point scored was for site No. 16 with No. 2 second. With this information, the votes of the Ways and Means Committee were about equally divided between site No. 2 and site No. 16. The final selection of site No. 16 by the Board of Supervisors was made on September 28. To what extent the supervisors were guided in their final selection by the analysis shown is uncer-

tain, but the fact remains that the choice was not made without the benefit of systematic comparison at least.

This subject was discussed in an article, "Selecting the Airport Site" (*American City*, May, 1928), and the method further elaborated in the *Associated Technical Societies Bulletin* (April, 1928) and in the *Engineering News Record* (September, 1928). More recent presentations by others will also be found in the technical publications.

Detroit City Airport

During the past eighteen months, the Department of Public Works, through the Airport Division of the City Engineer's Office and its Construction Division, has converted a rough, swampy river bed into an airport. This river bottom, 200 feet wide, 20 feet deep, its banks and borders covered with dense underbrush and used as a rubbish dump, has been graded, provided with fences, turf, concrete and asphalt runways, fuel, hangar, and other facilities. It affords excellent service for the hundreds of planes and thousands of pay-passengers that have taken advantage of the facilities offered since the beginning of practical operation in June, 1929.

The Detroit City Airport is one of the outstanding examples of close-in situation. It lies well within the city limits, five miles northeast of the City Hall and four and one-half miles due north from the river at Belle Isle Bridge. The right-of-way of the Detroit Terminal Railroad, an industrial belt line, adjoins the southern edge of the airport for more than a half mile.

The area of the field is now approximately 270 acres. Authorized additions will increase this to 300 acres in the near future. The land now owned by the City is in two strips separated by French Road. A plan to consolidate these parcels by vacating the street which lies between them has recently been approved by court decree.

Drainage. In general, the field at Detroit as finished is nearly flat and the elevation is 619 feet above sea level.

In addition to the large trunk sewers which extend the length of the airport, and which form a part of the city sewer system, there is a complete drainage layout consisting of laterals, drain tiles, and catch basins. This network is installed gridiron fashion over the field and is connected into the large

Connors Creek sewer underlying the airport. Adequately to drain the 250 acres within the airport boundaries required five miles of 12-inch to 18-inch lateral sewers and seventeen miles of 4-inch and 6-inch drain tile laid in trenches backfilled with one-half inch stone. These trenches were for the most part in parallel lines fifty feet apart. The tiles in these trenches were laid on a one per cent grade and the depth of the tiles below the surface was from three to four feet.

The drainage system for a number of airports has been worked out on the basis of soil characteristics very much as golf course drainage or farm drainage is designed. The planning of such work on the basis of intensities of storms and time of run-off for maximum economy has been conspicuously lacking. The importance of this latter form of investigation should receive greater emphasis. In Detroit the great variety of filling materials that went into the preparation of the field tended to render the results of a soil survey less informative than is ordinarily the case. The plan to build ultimately a comparatively large area of hard surface runways and aprons made the soil characteristics and tile drainage of less significance than it might otherwise have been.

A very excellent statement of some of the new phases of sewer design for airports is made by Mr. W. W. Horner in the *Engineering News Record*, November 7, 1929. Mr. Horner says: "It was concluded that a proper policy would involve the taking off of a one-year-frequency rain very nearly as fast as it falls, and that it would be undesirable to have water remaining on the field surface longer than two hours."

It was decided to design the drainage system on this basis, which was quite comparable to what would be used in a storm-water sewerage system, it being evident, of course, that any such system, if large enough to carry off rainfall as it fell, would be ample to serve also as main drainage or outlets for a system of tile drains.

We could find no record of any scheme or design covering the conditions outlined and were finally forced to make an extended research on a mass-time basis of the movement of water from a rainfall of this character. This work was carried out by E. E. Bloss and Clarence Miller, civil engineers of the department, in rather careful detail for a typical 30-acre unit. It involved studies of the effect of storms of different intensities and durations in flowing through a

provisionally determined system. The study required computations, at ten-minute intervals during such a storm, that would show instantaneous rates of discharge and total discharge as compared with the amount of rain falling, the amount of water in surface film, the amount in storage in porous rock backfill, and the amount in transit in drains. For this typical unit, a rain of about 45 minutes' duration seemed to give the most severe load, and a proper handling of the water with all allowances for storage and water in transit required a discharge capacity for the mains of about 0.42 cubic feet per second per acre, or about 30 per cent of the rainfall rate.

On account of the great amount of detailed computation required to go through, such a study for each piece of design was not considered practicable. Accordingly this rate of runoff was used for all similar areas and was modified somewhat for areas of other size and time characteristics.

The continuing development of a general field plan during and after the drainage work had been started has produced several conditions at variance with the original assumption as to type of surface, and further changes still possible indicate the futility of any application of extremely accurate methods to the design of this particular drainage system. However, in view of the immense amount of work of this character to be done throughout the country and the indications that a standard plan for airports will have been developed within the next year or two, to continue research studies of this kind under more normal conditions where the engineer is not faced with the necessity for immediate construction would seem highly desirable. It would not be difficult to bring together pertinent information and to plan a scheme of application of these data to a rational design so that a sound engineering technique might come into being.

The limited experience with the completed drains in the Detroit City Airport indicates that they are satisfactory. The installation at St. Louis, made as the results of the studies by Mr. Horner, is comparable to the Detroit practice.

Preparation of the Surface. Work at the Detroit City Airport has progressed on the full length of both sections of the field. The filling of the creek bed which traverses the field has been done during the past two years by opening it as a

dump for excavated material from city paving operations, sewer tunnels, and excavations for building foundations, and to a limited extent for a rubbish dump. Over 1,000,000 yards of fill were needed to bring the old gully up to the level of the landing areas. Other work incidental to the preliminary preparation of the field included the removal of buildings, trees and brush, fences, old subdivision sidewalks, telephone and electric light poles, and other objects within the limits of the field. In the westerly portion of the field, a \$200,000 garage and repair shop belonging to the water bureau of the Fire Department was vacated by them in June, 1928, and the building razed. The salvaged materials were used so far as possible in the reconstruction of the building on another site on the west side of the city.

Grading operations have been carried on with a view to having a smooth surface with no slope more than 2 per cent in any direction. The fills in some instances have exceeded 30 feet and allowance for shrinkage was necessary. A finish layer of top soil has been placed to make it possible to grow a sod on the field. The areas have been brought to grade and harrowed, fine graded, seeded, and rolled. Various seeds were used, some bluegrass and special mixtures. Vetch was sown in poor soil and some rye was used to protect the younger plants where needed.

Hard Surface Aprons and Runways. There is no general agreement in the practice of surfacing the runways. In some of the discussions it would seem as if a definite choice between hard surface runways or a sod surface over all must be made. We do not agree with this limiting choice but believe that the two types can be combined to good advantage.

The design and construction of runways is the feature of airport engineering that falls to the lot of the highway engineer. Only by means of a long smooth surface are airplanes enabled to take off and land at the prevailing high speeds. Not only is this a present condition, but if the airplane continues to develop along existing lines, it will be a condition for some time to come. More reliable construction of planes has enabled designers to decrease wing area, thus securing greater velocities, but at the same time requiring higher take-off and landing speeds. Accordingly, average landing speeds have increased rather than decreased in recent years, and not

even the most optimistic or radical of engineers can build an airport solely for helicopters. Only two or three years ago a landing speed of fifty miles per hour was common in commercial work, whereas sixty miles per hour is quite normal today. An airport designed to occupy a permanent place in national aviation must possess runways that are safe and convenient under all conditions.

Sufficient length to allow the plane to stop after a poor landing is therefore the most obvious requisite of a landing field. A hard surface with a satisfactory degree of smoothness is equally important, because if the wheels are unduly retarded, the plane tends to revolve about them; and when the overturning moment becomes greater than the resisting moment, the result is unfortunate. A strong wind across the runway tends to whip the plane off its course, and so the fact that the plane must head into the wind when landing necessitates runways in more than one direction.

The Detroit City Airport has two main runways about 80 degrees apart and intersecting at their lower ends. Each runway is to consist of two 100-foot-wide pavements, 300 feet apart on centers. One runway bears N. 35° 39' west and the other S. 63° 47' west. The north-south runway has a length of 4,900 feet and the east-west runway a length of 4,150 feet. The prevailing winds closely parallel the latter approach. A taxi strip near their intersection connects the runways with the concrete apron fronting the hangars. Another runway crossing both of these near their intersection has been provided.

Thus far, to accommodate planes landing and taking off, 3,450 lineal feet of concrete runways were built at a cost of \$87,295, and 7,900 lineal feet of asphaltic runways at a cost of \$148,452.58. All runways are 100 feet wide and completely drained. In addition, approximately 1,800 lineal feet of concrete aprons were constructed at hangar approaches. These total over 25,000 square yards of surface and vary in width from 100 to 150 feet.

The use of hard-surfaced runways will undoubtedly increase at airports where a schedule of flights must be maintained in all kinds of weather. At the Detroit airport such pavements are especially needed because clay forms a large part of the soil, which cannot be expected to drain quickly in wet weather despite the system of drain tiles now being installed.

It is planned to provide more runways when the additional area is annexed to the airport.

Three types of pavement have been used to surface the runways: one-course plain concrete, sheet asphalt on water-bound macadam base, and two-course bituminous concrete. The hundred-foot width of the one-course concrete is laid in eight strips with a longitudinal joint between the two central strips. Transverse expansion joints filled with pre-molded mastic are placed every thirty feet. They are edged to a half-inch radius. The thickness of the slab is seven inches.

The specifications for the concrete are the outgrowth of long experience with one-course streets and alleys in Detroit. A field mix of 1:2:3 is specified, with either pebbles or crushed stone permitted for the coarse aggregate. The grading of the sand is fully detailed and its fineness modulus must be between 2.60 and 3.60. Pebbles have a fineness modulus between 7.00 and 7.80, and range in size from 2-inch to $\frac{1}{4}$ -inch. Crushed stone is also graded from 2-inch down and must meet specified tests for hardness, toughness, and wearing quality. As in other city paving, water content is indirectly controlled through the consistency of the mix. A maximum slump of three inches is permitted, and to minimize variation it is specified that the mixer must have a water-measuring tank with a visible gauge. The time of mix is one minute.

Adequate curing of the concrete is secured by keeping it wet for seven days. Because it is recognized that plastic concrete contains more than enough water for complete hydration if evaporation is prevented, curing by silicate of soda has been permitted in the sections so far constructed. In this case the slab is covered with burlap as soon as it is finished and kept wet until hard enough to permit the application of the sodium silicate.

The obligation of the contractor to produce concrete meeting definite strength requirements is checked by test results. Cylinders made from the concrete going into the pavement must develop a strength of 2,500 pounds at the age of 28 days. Slab thickness as well as strength is determined by cores drilled from the completed pavement. These cores must show a compressive strength of 2,500 pounds at 28 days, 3,200 pounds at 90 days, and 4,000 pounds at one year.

Two sections of concrete runway under contract have been completed. Cores taken from these sections and tested at 28

days averaged 3,992 pounds per square inch. The cylinders made from this concrete showed an average strength of 3,362 pounds.

The bituminous concrete, or black base pavement, is more of an innovation in this city than the other type, but the engineers believe that it will be satisfactory for the kind of traffic for which it is designed. The fact that there is a large city-owned asphalt plant on the airport property made this kind of construction especially feasible. It consists of two inches of sheet asphalt over five inches of asphaltic concrete. The width is 100 feet and the cross-section shows a six-inch crown at the center. A line of porous six-inch tile in a gravel-filled trench is laid under each edge and the center line.

The asphaltic concrete base is a mixture of asphaltic cement with coarse and fine aggregates conforming to the following composition limits by weight:

Passing 2½ inch screen, retained on 1¼ inch.....	15 to 45%
Passing 1¼ inch screen, retained on ¼ inch.....	15 to 45%
Passing ¼ inch screen.....	25 to 40%
Bitumen (asphalt cement soluble in carbon disulphide)	4 to 7%

This mixture is delivered at a temperature of 225° F. to 325° F. and laid on a dry subgrade. It is laid on two layers so that it can be more completely compacted.

Part of the section of black base now being constructed lies over a filled-in water hole. The pressure of the roller served to bring water to the surface by an artesian well effect, producing muddy spots on the surface of the base. Spreading hay over the subgrade prevented recurrence of this trouble.

There are now three completed sections of the black base, one built by the Department of Public Works and two by private contractors. This work has been tested for depth by coring, and has averaged over the requirement.

The surface course consists of asphaltic cement, sand, and mineral dust, mixed to produce the following composition:

Bitumen	6 to 75%
Mineral matter passing 200-mesh screen.....	6 to 8%
Mineral matter passing 80-mesh screen.....	8 to 10%
Mineral matter passing 40-mesh screen.....	12 to 15%
Mineral matter passing 10-mesh screen.....	8 to 10%
Mineral matter passing ¾-mesh screen.....	45 to 55%

The asphalt mixtures for the sections constructed by the Department of Public Works were prepared at the neighboring municipal asphalt plant on French Road.

One section of runway 500 feet long was built during the winter when it was planned to hold the All-American Aircraft Show at the City Airport. Because of the fact that the ground was frozen, it was necessary to resort to blasting to prepare the grade. This section was built as a 3-inch sheet asphalt top on a 12-inch water-bound macadam base. The cost was not segregated from that of other work done at the same time, but is estimated at \$3.00 per square yard because of the unusual conditions under which the work was done.

In addition to this, there are 45,373 square yards of one course concrete 7 inches thick built or under contract, at an average cost of \$1.93, and 81,574 square yards of 2-inch asphalt on 5-inch black base at an average cost of \$1.59 per square yard. The totals for hard surface completed are 164,093 square yards, at a cost of \$282,811.31. Plans are being prepared for additional strips.

In a paper presented at the Eighth Annual Asphalt Paving Conference, West Baden Springs, Indiana, Mr. R. H. Simpson said that a prominent government official is quoted as saying recently that "the crying need of aviation today, in the United States, is one hundred properly equipped airports located at strategic points." There is no doubt of such need. But I would go further and say that the greatest need of air transportation today is paved take-off and landing areas at our airports. We must equip our airports so that they can be used twenty-four hours in the day and three hundred sixty-five days in the year. With transport ships flying on schedule and more such scheduled air lines being established monthly, we have reached a point where the delay to the departure of ships or the inability to land because of a muddy field is intolerable.

It is recognized that in some parts of the United States, such as the arid sections of the West with sandy soil, paved runways may never be required. An oil treatment will give a firm and dustless surface. There are also locations underlaid with gravel, that, no doubt, can be treated with asphaltic oils at nominal expense and produce a satisfactory surface. But the greater percentage of airport sites will require paved runways if dusty and muddy fields are to be avoided. I believe that the condition of the runways is now a deciding factor in determining the suitability of a field for the safe operation of a given plane.

Mr. Simpson presents eleven requirements for a suitable field:

1. It should be one that can be built at reasonable cost.
2. It should have a well drained subbase.
3. It should have a base to distribute the load.
4. It should have no abrupt change in grade.
5. It should have an even, true surface.
6. It should have a roughened or non-skid surface texture.
7. It should have a waterproof surface.
8. It should have a slope to carry off water.
9. It should have a dustless surface.
10. It should have good visibility from the air.
11. It should have a surface easily and quickly repaired.

The relative importance of these and other possible characteristics will vary for different airports. The task of weighting the requirements and designing the structure to satisfy the demands should be left in the hands of competent engineers.

Fence. A woven wire fence makes a satisfactory enclosure to keep out trespassers and prevent spectators from running into danger. The specifications for the Detroit City Airport permitted competitive bidding and called for a chain-link fence mounted on galvanized iron pipe frame, to stand 7 feet high above grade to the top of the wire fabric and top rail when erected. One foot additional height was required for the barbed wire extension arms.

The wire specified was heavily coated by the hot-dip process after weaving and was a No. 9 gauge wire woven in a two-inch chain. The line posts were at least $2\frac{1}{2}$ inches outside diameter and weighed 3.65 pounds per lineal foot; the corner posts were four inches outside diameter; no posts were farther apart than ten feet. All of the posts were set in 36 inches of concrete as a base. This base was not less than ten inches in diameter, extending 6 inches below the bottom of the post.

Two special gates were required, with 100-foot openings and swinging towards the street. The gate posts were 12 feet in height and required special foundations. The width of the gate will permit the passage of airplanes at the ground level and when swung open across the street, block street traffic until the airplane has crossed and the gate is again closed. The length of fence erected during the eighteen months totaled 22,600 feet, or close to four miles. The average cost of

this fence was \$1.55 per foot. Some ornamental iron fence was erected at a cost of \$2.33 per foot.

Lighting. The subject of lighting provoked considerable discussion at the First Aeronautical Conference held in Washington, D. C., and at subsequent meetings of a similar nature.

The requirements of the Department of Commerce for an "A" rating on night lighting are generally considered satisfactory and they include an airport beacon, an illuminated wind-direction indicator, boundary lights, flood lights, signal lights and a ceiling projector, building flood lights, obstruction lights.

Extensive studies and a great deal of experimental work by the larger electrical manufacturers put them in excellent position to advise as to the lighting requirements for any particular layout. Studies are being made of the most recent developments in airport lighting and it is hoped that some actual installation at the Detroit City Airport will be made before 1930.

Plans have been completed for a comprehensive lighting system, and the greater part of the work is under way. Lighting will comprise rotating, beacon, and boundary lights; approach lights; obstruction lights, field flood lights; and ceiling lights of the latest modern design.

The Hudson Motor Car Company, Dodge Brothers, and others are co-operating with us to the extent of erecting standard obstruction lights and markers on tall stacks and water towers near the Airport.

There are two circuits for boundary and approach lighting, each circuit surrounding one-half of the field. These circuits are 115/230 volts, each lamp being connected to the 115-volt circuit. The two live wires are No. 6 parkway cables and the neutral wires are bare. The lamps are spaced approximately 200 feet apart on cones, as specified by the Department of Commerce.

The obstruction lights are red, 100-watt lights, and where they are placed on smoke stacks or other inaccessible places the outlets are a double unit holding two lamps. This will minimize the replacement of these lamps.

The gas holder will be lighted by a system of three wire, 115/230-volt circuits. There will be three rings of red lights around the holder, $1/3$ and $2/3$ of the distance up the holder,

and one ring around the top. There will be 24 red lights in each ring, and the lamps will be connected alternately on two circuits. The feeder system to the holder is a double service so that if any part of the system fails, one-half of the lights will remain burning.

Considerable time was given to the design of control equipment. A control panel containing manually operated control switches is placed on the north wall in the manager's office, and a similar panel is located in the control tower. Each of these two panels contains fourteen control switches, which operate remote controlled contactors and oil switches. From either of these panels the operator can turn on or throw off the boundary and obstruction lights, the beacon, the lights marking the side of the hangar, the lights making letters as "Detroit City Airport" on top of the hangar, and the flood lights. The flood lighting will be controlled in such a way that in landing against the wind, the pilot will have light on the tail and side of the ship. The flood lights will be supplied with current from transformers close by.

There are 306 lamps of 500 watts each in the main hangar exclusive of the office section. The intensity of illuminations on the floor is approximately 4-foot candles. The total connected light and power load in the present installation will be over 300 kw. The total future light and power load will be approximately 1,200 kw.

Obstructions. At the present time, there are a number of obstructions surrounding the field, constituting a hazard for landing and taking off.

Plans provide for the removal of all of these obstructions in the near future. In the angle formed by the two runways is located a large gas holder 218 feet in diameter and 330 feet high, and painted a light gray. This gas holder is to remain for some time but is being suitably marked and lighted, thereby creating a landmark visible for many miles. Along the northwest-southeast leg and parallel thereto, high tension wires on poles constituted a hazard, which has been removed.

Small Hangar. The standard hangar and service accommodations essential to a complete airport are available. On August 15, 1928, the Common Council authorized the expenditure of \$80,000 to erect a hangar and to provide lighting for the field. This hangar has been completed and is now in use. It will accommodate twelve to fifteen planes, according to their

size. In addition it has rooms for supervising personnel and shops.

The hangar is a steel and brick building and was built for a contract price of \$52,025. The main building is approximately 100 feet square, with an addition on one end 20 feet by 80 feet. The building has large door openings on two sides 17 feet high by 90 feet wide, closed by round-the-corner type doors. All openings in the division wall between the addition and main building are closed with fire doors. A fire protection system consists of two standpipes with hose located in the main building and a sprinkler system for the machine shop.

A very pleasing appearance was obtained by the use of buff-colored face brick with cut stone trim, with stucco over the door openings. The interior wall is faced with salt-glazed tile, bonded to the exterior brick. The interior tile are full range buff tones. This wall is very easy to keep clean.

The hangar has an adequate lighting system of approximately one watt per square foot of area. The hangar is heated by means of floor- and roof-mounted unit heaters. These units discharge air at a high velocity from multiple outlets so arranged as to maintain a breathing line temperature of 55° F. under outside winter conditions.

Steam for heating this hangar will be supplied from the power house now being designed, which will provide steam for the main hangar under construction on the same field. At the present time steam for heating this building is from a temporary connection to the boilers located in the asphalt plant. Tanks and pumps for gas and oil have been installed.

Large Hangar. At the election in November, 1928, a bond issue of \$5,000,000 was authorized for the acquisition of additional land and the development of the site. The Council ordered the Department of Public Works to proceed with plans for the construction of a hangar and exhibition building to cost approximately \$1,000,000. The contract was let July 23 to the W. E. Wood Company. Another contract was let to Whitehead and Kales for the steel. This building is now practically complete. It will contain facilities for housing and servicing 200 or more planes, and all the necessary offices and appurtenances for the administration and public relations departments. The entire building will be available for the annual All-American Aircraft Show.

The building has an over-all length of 1,014 feet, an extreme width of 250 feet 5 inches at the southerly end, a middle width of 204 feet, and a width of 127 feet 5 inches for the northerly bay. The present plans provide for three main subdivisions: namely, the northerly bay 127 feet 5 inches by 114 feet 4 inches, adjacent thereto a section 193 feet 0 inches by 204 feet 0 inches, and the remaining southerly portion comprising the major portion of the hangar in one unit. The building may readily be subdivided into fifteen separate and distinct units by the addition of longitudinal and transverse fire walls, foundations supported on piling having been provided for these future walls.

Until such time as a separate administration building is constructed, provision has been made in the northerly bay for administration offices for the various activities of the port. Toilet facilities have been provided and so located that when the building is subdivided into 15 units, each unit will have a private toilet room.

The building is located on a portion of the field which in part was originally low ground and has a fill varying in depth from one foot to 40 feet. This condition of supporting soil necessitated a foundation supported on piling throughout; because the underground water level was assumed to be low, concrete piling was selected as the only permanent construction for this site.

All interior walls are to be faced with salt-glazed interior face brick tile. Salt-glazed brick is being used for its pleasing appearance and because it can be readily cleaned of all greases and dirt to which it will be subjected.

The roof will be 15-year-bonded composition roof on one-half inch of insulation supported by precast Haydite concrete channel tile roof deck.

The large hangar doors are the tubular straight track type door, providing a 20-foot by 99-foot clear opening in the small bays and a 25-foot by 149-foot opening in the large bay. Provisions have been made to increase the 25-foot doors to 30, if the future size of planes so requires. They are supported on 16-pound rails set flush with the finished floor. The top guide forms a plate girder along the lower cord of the truss, transferring the wind load to the columns.

The window areas are all enclosed with standard factory

steel sash, except the sash in the pylons, which is architecturally projected window sash.

Each bay is provided with three-inch standpipes with Detroit Fire Department two and one-half inch hose connection and 50 feet of one and one-half inch hose connected to the two and one-half inch valve by a swivel reducer. A capped six-inch riser is also provided in each bay for the future sprinkler system.

The water supply is by an eight-inch main from the city main to a six-inch main running down the center of the building, from which main all connections are taken.

The hangar proper will be heated by means of 30 American Blower Company's "Sirocco" floor-mounted unit heaters, utilizing steam at 125-pound square inch gauge pressure. These units will discharge air at a velocity of 1,600 feet per minute from multiple outlets so arranged as to maintain a breathing line temperature of 55° F. Units are thermostatically controlled and are provided with two speed motors. Each unit has an output in excess of 1,250,000 B.t.u.'s per hour, with steam at 125-pound gauge pressure and an entering air temperature of 50° F. The condensate from each unit is discharged into an overhead return system by means of crane tilt lifting traps. The overhead return system discharges the condensate into a receiver from which it is pumped back to the boiler plant.

The administration offices will be heated to 70° F. by means of direct radiation using low pressure steam.

Boiler Plant. Steam for the system is temporarily supplied by the boiler plant at the east side asphalt plant, which is equipped with oil burning boilers as follows: two 125-hp. Titusville H. R. T. boilers, two 250-hp. Freeman Scotch marine boilers.

Oil burning equipment is capable of firing the boilers to 150% of rating.

Heating Conduit. Steam is transmitted to the hangar over a distance of 2,300 feet through an 8-inch main. Condensate is returned to boilers through a 4-inch return line. The steam main and the return line are run in a Johns-Manville underground conduit. Ten manholes are provided to house the necessary expansion joints.

When a future hangar is constructed it is planned to construct a modern coal-burning boiler plant of approximately

2,200-boiler horsepower capacity, capable of being operated continuously at 200% of rating.

The hangar will be equipped with an adequate lighting system providing approximately one watt per square foot. Lights will be controlled from panel boards located near the entrance to each bay of the building. A control tower is so located as to give the operator an unobstructed view of the field and sky. This tower will house the control equipment for exterior lighting now being installed.

The award for the contract for construction of the main hangar was made at a contract price of \$609,500. The total cost of the building, including structural steel, fire walls, sprinkler system, and the proportion of the power plant chargeable to this building, is approximately one million dollars.

This main hangar is the major unit in the development of the Detroit City Airport and is to be followed by the erection of other buildings when needed. The other buildings contemplated when additional property is acquired are another hangar similar to the one now to be built, and an administration building and a power house of sufficient capacity to heat the present and future buildings that may be built on the port.

Plans and specifications are now being prepared for the power plant, which will be housed in a separate building and situated remotely from the main hangar. Underground steam lines will connect the power plant with the present and future buildings.

Air Marking. Keeping abreast of the nation-wide movement for proper air marking in cities, the City Engineer's Office has taken an active interest in this feature. Having obtained permission of the owners, department forces have painted standard chrome-yellow airway markers on the top of the First National Bank Building, as well as on the top of the four large gas holders scattered about the city. These markers consist of a north point, the words "Detroit City Airport", a direction arrow, and the distance in miles. Similar markers have been placed at other points through the courtesy of the Continental Motors Corporation and the Southeast Detroit Exchange Clubs.

Fire Protection. Upon the advice of the Detroit Fire Department, the west hangar has been equipped with the most modern fire-fighting devices, including sprinklers in the shop

section, a foam engine, foam extinguishers, and carbon tetrachloride extinguishers. The main hangar will be as well provided with similar equipment. The sprinklers in the larger hangar include a system laid in the floor as well as the usual overhead system.

Fueling System. In the early spring of 1929, development work at the Detroit City Airport had reached the stage where sufficient areas had been graded to allow landings and take-offs with some restrictions. The west hangar was nearing completion and numerous applications were being received from local operators for permission to use the airport.

The most important features to be considered from the standpoint of service being fueling facilities, investigations were made to determine just what type of equipment should be provided. Inquiries were addressed to the leading airports throughout the country and personal visits made to a number in the vicinity of Detroit.

Three principal types of fueling equipment were found to be in use: namely, the ordinary automobile service pump, specially constructed trucks with pumping equipment installed thereon, and the underground fueling pit supplied either from a manually operated pump or from remotely controlled electrical pumps. The first named method, being obviously a makeshift, was rejected on the grounds that it would not lend itself to the convenient maneuvering of airplanes in close proximity to the pump standard.

The second type of equipment considered was the portable tanks and pumps on trucks. This type of equipment is being used in a limited manner at some of the larger airports. It is rather more expensive than the other types in first cost and also in maintenance. It is also limited in capacity. It was found, however, to be quite suitable in airports where a very large number of three-motored or heavy-type planes are being serviced continually and in cases where it is used as an auxiliary service equipment. At large air meets it is practically indispensable. However, for general, all-around satisfactory and economical service day in and day out, the underground pit with the remote control electric pumping unit was considered to be best suited to our needs.

It might be of interest to add at this point that in the course of our investigations as to the types of equipment and where they might be obtained we found only one manufacturer of

this style of pump that carried on any advertising campaign, and it was only after considerable effort that we were able to obtain names of a number of other manufacturers.

Plans and specifications for one pumping unit were drawn up by the City Engineer's Office and public advertisements requesting proposals were run. The plans called for an underground pit to be located 75 feet from the hangar, connected to the electrically driven pump inside the hangar by suitable piping and wiring, with a 1,500-gallon storage tank located about midway between the two points. More or less general specifications were written for furnishing and installing a fueling system complete, with power pump storage tanks, piping, wiring, and all other appurtenances necessary to complete the system.

Inasmuch as the investigation disclosed that there were a number of satisfactory equipments on the market, specifications were so drawn that considerable latitude was allowed in the selection after the bids were opened.

The principal provisions in the specifications were the approximate size of the fueling pit and the materials entering into it. A general description of the meter, with its capacity, sediment chambers, length, size, and type of hose and nozzles, and general specifications on the storage tank were to meet the Underwriters' Laboratory's specifications. The pump was specified to be 1 $\frac{1}{4}$ -inch, motor-driven, rotary, hazardous liquid pump, having a capacity of not more than 20 gallons per minute. All equipment was to bear the Underwriters' label.

The electric wiring for pumps, motor, and control was specified to be in galva-duct, Sherra-duct, or equal iron conduits. A pushbutton remote control switch, as well as a positive key locking device, was specified.

Three proposals were received, the lowest bid being \$685.00, for all the equipment to be installed complete, ready for operation, the work to be done within the specified time (30 days). The equipment has now been in service daily for over six months and thus far there has never been any complaint regarding its operation. It has been suggested that it might be improved upon by tilting the face of the meter to an angle of 45°, thereby making it more easily read by the operator.

After the equipment was ready for operation, an investigation was made as to the proper gasoline to be supplied, inasmuch as but one tank was in service and it would be neces-

sary to handle but one brand of gasoline at a time. The aviation gasoline used is purchased by the City Department of Purchases and Supplies under the name of "U. S. Domestic Grade Aviation Fuel", as described in Technical Paper 323-B, Department of Commerce. At the time Domestic Grade Fuel was adopted by the City Oil Committee of the Detroit Associated Technical Societies, there was no supply of Fighting Grade aviation gasoline; so Domestic Grade was accepted. Because of the refiner's necessity of having a more volatile aviation fuel, the end point was lowered and the gasoline as now received at the airport is even beyond Fighting Grade specifications.

Another important factor in gasoline is the anti-knock quality. At the present time, the City has no anti-knock testing machine to determine the detonation characteristics of gasoline, but we are making arrangements either to purchase one or to have an independent laboratory purchase one. This test is made in a regular gasoline motor with a bouncing pin. The standard fuels with which to measure or compare the gasoline are Iso-Octane and Normal-Haptane. The test is already adopted for our motor gasoline and is very important because of the high compression motors of today. Other tests on our aviation fuel include the color, corrosion, and doctor tests. The doctor test determines whether the gasoline is sweet or sour.

Lubricating oil for aviation motors is of the utmost importance and price cannot enter into the purchase considerations. At the time of our first purchase of lubricating oil for the Airport, there was available to the City only one oil which met all the following characteristics:

1. 100% paraffine base
2. High flash and fire points (500° F. minimum)
3. Flat viscosity ratio curve
4. Viscosity at various temperatures
5. Low carbon content
6. Very light color (No. 6 N. P. A. maximum)
7. Low four point

Up to the present time that grade of lubricating oil has been used exclusively. Recently, however, other grades of oil, to meet the specifications, have been made available and it is intended that a variety of lubricating oils be carried in stock to meet the requirements of the various operators.

The operation of the single pumping unit described has been more or less in the nature of an experiment in operating methods looking forward to the installation of the larger pit in connection with the main hangar. Studies were made as to whether all of the six pits proposed for the larger unit should be connected to one central pumping plant or whether they should be operated independently. The advantage of separate units is that they will allow the option of furnishing several different brands of gasoline as demands may require, although the necessity for furnishing such a variety has not yet been fully established.

The question of giving concessions to various gasoline producers has been seriously considered and the evidence up to this time is in favor of a municipally operated and controlled fuel system, whatever the type of equipment or number of products may be distributed.

The City has now under contract a fueling system for the main hangar. The plans call for the installation of four 15,000-gallon storage tanks and four fueling pits, and the necessary pumps and control equipment. All are to be located at the north end of the main hangar. Four additional fueling pits are to be installed when required. The hydraulic flotation system is to be used. The system is so arranged that fuel may be delivered from any storage tank to any fueling pit at the rate of 25 gallons per minute. This will permit the delivery of any one of four different brands of fuel to any fuel pit.

Ultimately it is planned to lay a pipe line from the railroad siding to the storage tanks in order that fuel may be purchased in tank car lots.

Portable oil tanks and pumps and all other accessories that go to proper servicing are at hand.

Snow Removal. The heavy fall of snow in December provided an excellent opportunity to gain valuable experience at first hand as well as to observe operations at other ports.

Because of the number of light planes using the field it was considered desirable to clear the runways. This was done by plows that left the snow piled in high ridges at the sides of the runway. These banks were loaded by steam shovels into trucks and hauled away. A comparatively new machine for removing snow was purchased. This was the SNOGO. There are few of these machines in use and their first cost is high,

but it was thought the possibilities of its use were enough to warrant the purchase. Subsequent demonstration has apparently justified this decision.

Rules—Rates. Complete rules governing the operation of the field and hangar have been formulated and printed copies are available for distribution. These booklets also carry a schedule of rates for hangar rental and supplies.

Forms. Records of all sales of gas and oil, of rentals, and of services are kept by means of a combination autographic register and cash drawer. Daily reports on standard forms are made out by attendants. These cover all phases of field and hangar operation, such as passengers carried, landings made, gas and oil sold, and numerous other matters of interest.

Policies. As set forth by the writer in a letter to the Commissioner, October 5, 1928, the policies as applied to the use of the field should be left to determination as the need arises.

The Detroit City Airport will be dedicated to the advancement of the art of flying. It is a municipal enterprise and as such must through its commercial and popular uses render an accounting to the City and to the people.

Its commercial use must be such as to increase to the utmost the prestige of our City throughout the world. Its popular use must give the maximum returns to the greatest number of citizens. Every activity which is proposed should be carefully examined with these two controlling principles in mind.

The rates which are to be fixed on today's commercial airport business cannot be planned primarily to get the user's interest on his investment in the land and structure. There may come a day when such a thing is possible and it may not be far off, but to apply such strictures now would bring that part of the business to a dead halt. It would defeat the purpose of the enterprise and build for our city not prestige, but notoriety. Below this money-making level, there are rates which may well be imposed for commercial service and which the business end of flying can well afford and usually is willing to pay.

The service to the people is rendered in many ways. To a very limited extent this is through landing and housing facilities afforded private owners of planes. To a greater extent the people benefit by the time saved for express and mail serv-

ice. Another and more direct realization of benefit is in the carrying of passengers to and from distant cities. The greatest direct return to the greatest number of people is unquestionably rendered by the sightseeing tours. The passengers on such planes become likely customers for the longer trips and usually are enthusiastic supporters of other aviation activities.

The use to which the Detroit City Airport can be put should be determined as the necessity for such decision arises. The necessity for restricting or the desirability of expanding the uses of any airport might well be based on the recommendation of the manager. The Detroit City Airport has as yet reached no stage of congestion where any legitimate use need be denied.

The regulations of the U. S. Department of Commerce, which are followed by the Michigan law and the City ordinance, tend to safeguard the operation of the aircraft. The authority granted to the Commissioner of Public Works to control the field will supplement these safeguards in an effort to make any authorized use of the field a credit to the City and a source of satisfaction to the people.

Administration. Pending the completion of the main hangar, with consequent increase in operations and traffic, some valuable experience is being gained through the active operation of the west hangar, so that as the volume of business increases most of the rough edges incidental to the inauguration of new and untried methods will have been smoothed out. Twenty-four hour service is given at the hangar, two attendants being on duty during the day and one man on each of two shifts all night.

The skeleton of the proposed organization has been prepared and is now being discussed with the Civil Service Commission. At present the work is being handled as a special assignment by members of the City Engineer's staff. This is clearly the proper arrangement during the construction period but probably not one that could be continued indefinitely to good advantage.

A standard airport register is provided in which the arrival and departure of planes is kept, with other relative information, such as pilots' names, plane numbers and types, destination. An interesting ten minutes can be spent in thumbing

over the pages of the register. Autographs of pilots from California to Maine and from Texas to Canada will be found there.

For the convenience of pilots, a complete set of airway maps mounted on wall-board are kept in a special storage cabinet. In this set are individual maps of each of the forty-eight states and the Province of Ontario. These are special maps showing all airways, airports, and beacons. Protractors, compasses, and other instruments for use with the maps are also provided. Supplementing the maps, Department of Commerce bulletins showing over 600 airports with detailed maps and descriptions are kept in three neatly bound and indexed leather books. Through the courtesy of the 107th Squadron, Michigan National Guard, at the field, weather reports received by radio at frequent intervals are posted on standard forms on the bulletin board.

An illuminated all-metal wind tee and standard wind sock are mounted on the roof of the hangar. A compass compensator 50 feet in diameter has been laid out by means of brass plugs set in the end of one of the asphalt runways. Metal lockers for pilots are furnished. Wheel chocks, tail skid and wheel dollies, and other accessories are kept on hand at all times.

With the co-operation of the Police Department the entire Airport is constantly patrolled by a uniformed member of the police force, equipped with a Ford car with the top removed for better visibility.

The hangars, three sections of runway, and the new fencing were built under contract. All of the other development has been carried out by the Construction Division of the Department of Public Works. Both contract and force account operations are under the general supervision of the City Engineer. Details of development and management have been under the direction of W. J. Wallace, Acting Manager of the Airport; building construction under M. F. Wagnitz; sewer design under Robert R. Reom; tests and specifications under Floyd C. Morse; property studies under E. O. Eck; and road, runways, and sewer construction under Charles R. Lark, assisted by J. H. McLean and Charles Hawman.

All engineering design has been carried out in the office of the City Engineer and all field engineering supplied by the

Survey Division of the same office, under Walter Starkweather, with R. Longworth in charge of field party. Inspection of construction was by Fred J. Legg, except the steel in the main hangar, which was inspected by the Detroit Testing Laboratories.

At the present time most of the airport managers are pilots. The proportion may continue to be large but not because being a pilot is an essential requirement for the position. The characteristics of the business man and the engineer seem to fit immediate needs better, at least through the development stages.

SOME DEVELOPMENTS IN DESIGN AND CONSTRUCTION OF HIGHWAYS

By Wm. J. Titus, Chief Engineer, Indiana State Highway Commission

Highway design should begin with the first inspections preparatory to making surveys. Speaking broadly, the design is the basis on which the survey studies are to be carried out. As the details are developed by progressive steps from the first surveys to the final plan layout, it becomes increasingly apparent that the design is the foundation of the whole of the work.

We are inclined to rush a survey party into the field and drive stakes, only to find that much of this work must be scrapped and new lines run because the first work could not be fitted to the design so as to fulfil the requirements. The locating engineer must have a full understanding of the operation and maintenance of the road and the ability to picture the completed project.

The trend of highway design is toward a much higher standard of alignment, grades, width, and surface. The public's money is invested in these roads and the public is entitled to the greatest possible use of the roads with safety. This requires the most careful study of the widths, the surface, the grades, and the alignment. The highway funds in Indiana are usually secured from all the users of the roads; so it is no more than fair that the roads should be designed for their benefit rather than the benefit of abutting properties.

It is very desirable that roads be constructed with shoul-